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METHOD AND SYSTEM FOR PROVIDING AN INTELLIGENT SWITCH IN A HYBRID WIRED/WIRELESS LOCAL AREA NETWORK

CROSS-REFERENCE TO RELATED APPLICATIONS/INCORPORATION BY REFERENCE

[01] This application makes reference to, claims priority to and claims the benefit of:

United States Provisional Patent Application Serial No. 60/433,131 entitled "Method and System for Providing a Wireless Access Point (WAP) having Integrated Switching Capability in a Hybrid Wired/Wireless Network" filed on December 13, 2002;

United States Provisional Patent Application Serial No. 60/411,261 entitled "Communications Systems Software and Protocols" filed on September 17, 2002;

United States Provisional Patent Application Serial No. 60/411,301 entitled "Method and System for Providing a Scalable Integrated Switch and Wireless Architecture" filed on September 17, 2002; and

United States Provisional Application Serial No. 60/435,984 entitled "Communication System and Method in a Wireless Local Area Network" filed on December 20, 2002.

[02] The above stated applications are all incorporated herein by reference in their entirety.

FIELD OF THE INVENTION

[03] Embodiments of the present application relate generally to local area networks, and more particularly to a switching system and method in a hybrid wired/wireless local area network (WLAN).

BACKGROUND OF THE INVENTION

[04] The Open Systems Interconnection (OSI) model promulgated by the International standards organization (ISO) was developed to establish standardization for linking heterogeneous computer and communication systems. The OSI model describes the flow of information from a software application of a first computer system to a software application of a second computer system through a network medium. FIG. 1a is a block diagram 100 of the OSI model. Referring to FIG. 1a, the OSI model has seven distinct functional layers including layer 7, an application layer 114; layer 6, a presentation layer 112; layer 5, a session layer 110; layer 4, a transport layer 108, layer 3, a network layer 106; layer 2: a data link layer 104; and layer 1, a physical layer 102. The physical layer 102 may further include a physical layer convergence procedure (PLCP) sublayer 102b and a physical media dependent sublayer 102a. The data link layer 104 may also include a Medium access control (MAC) layer 104a.

[05] In general, each OSI layer describes certain tasks which are necessary for facilitating the transfer of information through interfacing layers and ultimately through the network. Notwithstanding, the OSI model does not describe any particular implementation of the various layers. OSI layers 1 to 4 generally handle network control and data transmission and reception, generally referred to as end-to-end network services. Layers 5 to 7 handle application issues, generally referred to as application services. Specific functions of each layer may vary depending on factors such as protocol and/or interface requirements or specifications that are necessary for implementation of a particular layer. For example, the Ethernet protocol may provide collision detection and carrier sensing in the physical layer. Layer 1, the physical layer 102, is responsible for handling all electrical, optical, opto-electrical and mechanical requirements for interfacing to the communication media. Notably, the physical layer 102 may facilitate the transfer of electrical signals representing an information bitstream. The physical layer 102 may also provide services such as, encoding, decoding, synchronization, clock data recovery, and transmission and reception of bit streams.

[06] The PLCP layer 102b may be configured to adapt and map services provided by the physical layer 102 to the functions provided by the device specific PMD sublayer 102a. Specifically, the PLCP layer 102b may be adapted to map PHY sublayer service data units (PDSUs) into a suitable packet and/or framing format necessary for providing communication services between two or more entities communicating via the physical medium. The PMD layer 102a specifies the actual methodology and/or protocols which may be used for receiving and transmitting via the physical medium. The MAC sublayer 104a may be adapted to provide, for example, any necessary drivers which may be utilized to access the functions and services provided by the PLCP sublayer 102b. Accordingly, higher layer services may be adapted to utilize the services provided by the MAC sublayer 104a with little or no dependence on the PMD sublayer 102a.

[07] 802.11 is a suite of specifications promulgated by the Institute of Electrical and Electronics Engineers (IEEE), which provide communication standards for the MAC and physical (PHY) layer of the OSI model. The 801.11 standard also provides communication standards for wired and wireless local area networks (WLANs). More specifically, the 802.11 standard specifies five (5) types of physical layers for WLANs. These include, frequency hopping spread spectrum (FHSS), direct sequence spread spectrum (DSSS), infrared (IR) communication, high rate direct sequence spread spectrum spread spectrum (HR-DSS) and orthogonal frequency division multiplexing (OFDM). The 802.11 standard also provides a PLCP frame format for each of the specified PHY layers.

[08] Over the past decade, demands for higher data rates to support applications such as streaming audio and streaming video, have seen Ethernet speeds being increased from about 1-2 megabit per second (Mbps), to 10 Mbps, to 100 Mbps, to 1 gigabit per second (Gbps) to 10 Gbps. Currently, there are a number of standards in the suite of specifications, namely 802.11b, 802.11a and 802.11g which have been adapted to facilitate the demands for increased data rates. The 802.11g standard for example, provides a maximum data rate of about 54 Mbps at a transmitter/receiver range of 19 meters (m) in a frequency range of 2.4 GHz to 2.4835 GHz. The 802.11b

standard for example, may be adapted to provide a maximum data rate of about 11 Mbps at a transmitter/receiver range of 57 meters (m) in a frequency range of 2.4 GHz to 2.4835 GHz. Finally, the 802.11a standard for example, provides a maximum data rate of about 54 Mbps at a transmitter/receiver range of 12 meters (m) in a 300 MHz segmented bandwidth ranging from 5.150 GHz to 5.350 GHz and from 5.725 GHz to 5.825 GHz.

[09] The 802.11 standard forms the basis of the other standards in the suite of specifications, and the 802.11b, 802.11a and 802.11g standards provide various enhancements and new features to their predecessor standards. Notwithstanding, there are certain elementary building blocks that are common to all the standards in the suite of specifications. For example, all the standards in the suite of specifications utilize the Ethernet protocol and utilize carrier sense multiple access with collision avoidance (CSMA/CA).

[10] CSMA/CA utilizes a simple negotiation scheme to permit access to a communication medium. If a transmitting entity wishes to transmit information to a receiving entity, the transmitting entity may sense the communication medium for communication traffic. In a case where the communication medium is busy, the transmitting entity may desist from making a transmission and attempt transmission at a subsequent time. In a case where the communication transmission is not busy, then the transmitting entity may send information over the communication medium. Notwithstanding, there may be a case where two or more transmission entities sense that the communication medium is not busy and attempt transmission at the same instant. To avoid collisions and retransmissions, a CSMA/OA or ready to send (RTS) and clear to send (CTS) messaging scheme may be employed, for example. Accordingly, whenever a transmitting device senses that the communication medium is not busy, then the transmitting device may send a ready to send message to one or more receiving device. Subsequent to the receipt of the ready to send message, the receiving device may send a clear to send message. Upon receipt of the clear to send message by the transmitting device, the transmitting device may initiate transfer of data

to the receiving device. Upon receiving packets or frames from the transmitting device, the receiving device may acknowledge the received frames.

[11] The 802.11b standard, commonly called Wi-Fi, which represents wireless fidelity, is backward compatible with its predecessor standard 802.11. Although 802.11 utilizes one of two modulation formats including direct sequence spread spectrum (DSS) using differential binary phase shift keying and frequency hopping spread spectrum (11-bit Barker sequence), 802.11b utilizes a higher data rate form of DSS called complementary code keying (CCK). CCK permits higher data rate and particularly less susceptible to interference effects such as multipath-propagation interference, the PSK.

[12] 802.11a utilizes orthogonal frequency-division multiplexing (OFDM) modulation/encoding scheme, which provides a maximum data rate 54 Mbps. Orthogonal frequency-division multiplexing is a digital modulation technique which splits a signal into several narrowband channels, with each channel having a different frequency. Each narrowband channel is arranged so as to minimize the effects of crosstalk between the channels and symbols in the data stream.

[13] Since equipment designed to provide support for 802.11a operates at frequencies in the ranges 5.150 GHz to 5.350 GHz and from 5.725 GHz to 5.825 GHz, 802.11a equipment will not interoperate with equipment designed to operate with the 802.11b standard which defines operation in the 2.4 to 2.4835 GHz frequency band. One major drawback is that companies that have invested in 802.11b equipment and infrastructure may not readily upgrade their network without significant expenditure.

[14] The 802.11g standard was developed as an extension to 802.11b standard. The 802.11g standard may utilize a similar OFDM modulation scheme as the 802.11a standard and delivers speeds comparable with the 802.11a standard. Since 802.11g compatible equipment operates in the same portion of the electromagnetic spectrum as 802.11b compatible equipment, 802.11g is backwards compatible with existing 802.11b WLAN infrastructures. Due to backward compatibility of 802.11g with 802.11b, it would be desirable to have an 802.11b compliant radio card capable of interfacing directly with

an 802.11g compliant access point and also an 802.11g compliant radio card capable of interfacing directly with an 802.11b compliant access point.

[15] Furthermore although 802.11g compatible equipment operates in the 2.4 GHz to 2.4835 GHz frequency range, a typical transmitted signal utilizes a bandwidth of approximately 22 MHz, about a third or 30% of the total allocated bandwidth. This limits the number of non-overlapping channels utilized by an 802.11g access point to three (3). A similar scenario exists with 802.11b. Accordingly, many of the channel assignment and frequency reuse schemes associated with the 802.11b standard may be inherent in the 802.11g.

[16] RF interference may pose additional operational problems with 802.11b and 802.11g equipment designed to operate in the 2.4 GHz portion of the electromagnetic spectrum. The 2.4 GHz portion of the spectrum is an unlicensed region which has been utilized for some time and is crowded with potential interfering devices. Some of these devices include cordless telephone, microwave ovens, intercom systems and baby monitors. Other potential interfering devices may be Bluetooth devices. Accordingly, interference poses interference problems with the 802.11b and 802.11g standards.

[17] 802.11a compatible equipment utilizes eight non-overlapping channels, as compared to three non-overlapping channels utilized by 802.11b. Accordingly, 802.11a access points may be deployed in a more dense manner than, for example 802.11b compatible equipment. For example, up to twelve access points each having a different assigned frequency may be deployed in a given area without causing co-channel interference. Consequently, 802.11a may be particularly useful in overcoming some of the problems associated with channel assignment, especially in areas that may have a dense user population and where increased throughput may be critical. Notwithstanding, the higher operating frequency of 802.11a causes more attenuation resulting in a shorter operating range at a given data rate. This may significantly increase deployment cost since a larger number of access points are required to service a given service area.

[18] In hybrid wired/wireless network systems that may utilize one or more protocols in the 802.11 suite of protocols, the mobility of access devices throughout the network may pose additional challenges for conventional switches and switching equipment. Since access devices are continuously changing their point of access to the network, conventional switches may not have the capability to control other network devices and/or entities to provide seamless communication throughout the network. Moreover, particularly in systems that may handle large volumes of access device traffic, conventional switching and signaling may consume significant amounts of bandwidth that may reduce available bandwidth and effectively reduce system throughput.

[19] Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of skill in the art, through comparison of such systems with some aspects of the present invention as set forth in the remainder of the present application with reference to the drawings.

BRIEF SUMMARY OF THE INVENTION

[20] Aspects of the invention provide a system and method for communicating in a hybrid wired/wireless local area network. A method for communicating in a hybrid wired/wireless local area network may include sending a first messaging protocol message between a first switch and a first access point. In response to the first messaging protocol message, receiving at least a second messaging protocol message from the first access point and/or the first switch. One or more of the first and second messaging protocol message and/or a third messaging protocol message may be used to control one or more of the first switch, a second switch, a first access point, a second access point, and one or more access devices.

[21] The first messaging protocol message may be generated by the first switch. The second messaging protocol message may be generated by the second switch in response to the generation of the first messaging protocol message. The first, second and/or third messaging protocol message may be, for example, (1) an access point status message, which may be communicated between the first access point and the second access point; (2) an access point configuration message, which may be communicated from the first switch and/or the second switch, to the first access point and/or the second access point; (3) a switch status message, which may be communicated between the first switch and the second switch; (4) a switch configuration message, which may be communicated between the first switch and the second switch; (5) a client status message, which may be communicated from the first access point and/or the second access point to the first switch and/or the second switch; (6) a device discovery message, which may be communicated between the first switch and the second switch, between the first switch and at least one of the first access point and the second access point, and between the first access point and at least one of the second access point and one or more of the access devices; and/or (7) a switch status message, which may be communicated between the first switch and the second switch.

[22] Another embodiment of the invention may provide a machine-readable storage, having stored thereon a computer program having at least one code section for providing communication for a switch in a hybrid wired/wireless local area network, the at least one code section executable by a machine for causing the machine to perform the steps described above.

[23] Another embodiment of the invention may provide a system for communicating in a hybrid wired/wireless local area network. The system may include a switch having a transmitter, which may be adapted to send a first messaging protocol message between a first switch and a first access point. The switch may include a receiver which may be adapted to receive a second messaging protocol message from the first access point and/or the first switch. The receiver may be adapted to receive a second message, which may be responsive to the transmittal of the first messaging protocol message. A controller may be adapted to control one or more devices using the first messaging protocol message, second messaging protocol message and/or third messaging protocol message. These devices controlled by the controller may include, but are not limited to, the first switch, a second switch, the first access point, the second access point, and one or more access devices.

[24] The generator may be adapted to generate the first messaging protocol message from the first switch and the receiver may be adapted to receive the second messaging protocol message from the second switch. The processor may be configured to control the transmitter, the receiver, the controller and the generator. The processor may utilize one or more messaging protocol messages to control any one or more of the transmitter, receiver, generator, QoS controller, load balancing controller, session controller and/or network management controller.

[25] The first messaging protocol message and the third messaging protocol message generated by the switch may be, for example, (1) an access point status message, which may be communicated between the first access point and the second access point; (2) an access point configuration message, which may be communicated from the first switch and/or the second switch, to the first access point and/or the

second access point; (3) a switch status message, which may be communicated between the first switch and the second switch; (4) a switch configuration message, which may be communicated between the first switch and the second switch; (5) a client status message, which may be communicated from the first access point and/or the second access point to the first switch and/or the second switch; (6) a device discovery message, which may be communicated between the first switch and the second switch, between the first switch and at least one of the first access point and the second access point, and between the first access point and at least one of the second access point and one or more of the access devices; and/or (7) a switch status message, which may be communicated between the first switch and the second switch.

[26] These and other advantages, aspects and novel features of the present invention, as well as details of an illustrated embodiment thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

[27] FIG. 1a is a block diagram of the OSI model.

[28] FIG. 1b is a block diagram illustrating a general PLCP frame as defined by 802.11.

[29] FIG. 1c is a block diagram illustrating a PLCP frame utilized by frequency hopping spread spectrum as defined by 802.11.

[30] FIG. 1d is a block diagram illustrating a PLCP frame for direct sequence spread spectrum and high rate direct sequence spread spectrum as defined by 802.11.

[31] FIG. 1e is a block diagram illustrating a PLCP frame for orthogonal frequency division multiplexing as defined by 802.11.

[32] FIG. 2 is a block diagram of an exemplary system for network management in a wireless local area network in accordance with an embodiment of the invention.

[33] FIG. 3 is a block diagram of an exemplary Enterprise Wireless LAN having switches serving as the edge managers in accordance with an embodiment of the invention.

[34] FIG. 4 illustrates an exemplary exchange sequence between a switch and an access point on a status request on the access point using the message protocol in accordance with an aspect of the invention.

[35] FIG. 5 illustrates a switch filter transfer using the messaging protocol in accordance with an embodiment of the invention.

[36] FIG. 6 illustrates an exemplary message exchange between a switch and an access point using a messaging protocol in accordance with an aspect of the invention.

[37] FIG. 7 is an exemplary diagram illustrating an exemplary message exchange for locating a wired client device using the messaging protocol in accordance with an embodiment of the invention.

[38] FIG. 8 is a block diagram of an exemplary switching system for network management in a wireless local area network.

[39] FIG. 9 is a block diagram of an exemplary session control process as described in FIG. 8 that may be utilized by the switching system for network management in accordance with an embodiment of the invention.

[40] FIG. 10 is a block diagram of an exemplary load balancing process as described in FIG. 8 that may be utilized by the switching system for network management in accordance with an embodiment of the invention.

[41] FIG. 11 is a block diagram of an exemplary QoS enabling process as described in FIG. 8 that may be utilized by an the switching system for network management in accordance with an embodiment of the invention.

[42] FIG. 12 is a block diagram of an exemplary switch in accordance with an aspect of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[43] Aspects of the invention provide a system and method for communicating in a hybrid wired/wireless local area network. A method for communicating in a hybrid wired/wireless local area network may include sending a first messaging protocol message between a first switch and a first access point. In response to the first messaging protocol message, receiving at least a second messaging protocol message from the first access point and/or the first switch. One or more of the first and second messaging protocol message and/or a third messaging protocol message may be used to control one or more of the first switch, a second switch, a first access point, a second access point, and one or more access devices.

[44] FIG. 1b is a block diagram 120 illustrating a general PLCP frame as defined by 802.11. Referring to FIG. 1b, there is shown preamble 122, PLCP header 124, MAC data 126, and CRC 128. Preamble 122 may include synchronization (SYNC) data 122a and synchronization delimiter 122b. The PLCP header 124 may include, for example PLCP signal field (PSF) 124a, service data 124b, length 124c and other fields. The preamble 122 may be dependent on the PHY. The SYNC data 122a may include a unique bit stream that may be adapted to signal timing parameters such as the start of a frame. The SYNC data 122a is used for bit synchronization and demodulation. The SYNC delimiter 122b provides frame timing information and may be adapted to delimit the end of synchronization information. The PLCP header 124 may be adapted to contain information used for decoding the frame. For example, the PSF 124a may be adapted to include communication data rate information. The service data 124b is generally reserved, but may be utilized to provide application specific functionality. The length 124c may be adapted to indicate the length of the MAC data 126. In this regard, the length 124c may be expressed in terms of the time required to transmit the MAC data 126.

[45] FIG. 1c is a block diagram 130 illustrating a PLCP frame utilized by frequency hopping spread spectrum as defined by 802.11. Referring to FIG. 1c, there is shown a

SYNC data 132, PLCP header 134 and PSDU 136. The PLCP header 134 may include, for example, PSDU length word (PLW) 134a, PLCP signaling field (PSF) 134b, header error check field or CRC 134c and other fields. The PLW 134a may specify the number of octets contained in the PSDU 136. The PSF 134 be may be 4-bits in length and may be used to denote the communication data rate.

[46] FIG. 1d is a block diagram 140 illustrating a PLCP frame for direct sequence spread spectrum and high rate direct sequence spread spectrum (HR-DSS) as defined by 802.11. Referring to FIG. 1d, there is shown preamble 142, PLCP header 144 and MPDU 146. Preamble 142 may include synchronization (SYNC) data 142a and synchronization delimiter 142b. The PLCP header 144 may include PLCP signal field (PSF) 144a, service data 144b, length 144c, and CRC field 144d. The SYNC data 142a may be 128 bits as compared to 8 bits for SYNC data 132a for frequency hopping spread spectrum. The CRC 144d is 16 bits, which is similar to CRC 134c for frequency hopping spread spectrum.

[47] FIG. 1e is a block diagram 150 illustrating a PLCP frame for orthogonal frequency division multiplexing as defined by 802.11. Referring to FIG. 1e, there is shown preamble 152, PLCP header 154 and PSDU 156, tail 158 and pad 160. Preamble 152 may include synchronization (SYNC) data 152a and synchronization delimiter 152b. The PLCP header 154 may include length 154a, PLCP signal field (PSF) 154b, reserved field 154c, parity 154d, tail 154e and service 154f. The length 154a is a 12-bit field that may be adapted to indicate the length of the frame. The PSF 154b is a 4-bit field that may indicate a modulation scheme utilized and its associated coding rate of the PSDU. For example, the specification utilizes binary 1011 to represent 6 Mbps, 1111 to represent 9 Mbps, 1010 to represent 12 Mbps, 1110 to represent 18 Mbps, 1001 to represent 24 Mbps, 1011 to represent 36 Mbps, 1000 to represent 48 Mbps and finally, 1100 to represent the maximum standardized rate if 54 Mbps. The reserved field 154c is a 1 bit field that is reserved for future use and may be adapted for application specific use. The parity field 154d may indicate odd or even

parity. The tail field 154e is a 6-bit field. The service field 154f is a 16-bit field that may be adapted to indicate the type of service.

[48] In a typical wireless local area network, especially as access devices become mobile throughout the network, channel capacity may be rapidly time varying. For example, when the distance from an access device to an access point increases or decreases due to mobility, the channel capacity and ultimately the channel throughput may change with time. In accordance with an embodiment of the invention, a switch is provided to facilitate communication between one or more of a plurality of access devices and/or access points, and/or other switches. The switch may utilize a messaging protocol, which may be adapted to provide, for example, switch filter transfer, bandwidth management, session control and management, load balancing and/or QoS control and management.

[49] In, for example, a hybrid wired/wireless in which bandwidth my be rapidly changing over time due to access device mobility, a switch, in accordance with an aspect of the invention, may be adapted to perform bandwidth management for a wired and/or a wireless portion of the network. The bandwidth management may include, but is not limited to, performing one or more tasks including, but not limited to, implementing policies, tracking bandwidth usage and adapting bandwidth allocation to meet user demands and system capability. The management of these tasks may pertain to providing mobility and operability throughout a hybrid wired/wireless communications network.

[50] FIG. 2 is a block diagram of an exemplary system for network management in a wireless local area network in accordance with an embodiment of the invention. Referring to FIG. 2, there is illustrated a first networking domain 214 and a second networking domain 234. The first networking domain 214 may include a switch 202, and access points 204, 206, 208, 210, 212. Each of access points 204, 206, 208, 210, 212 may be coupled to the switch 202. The second networking domain 234 may include a switch 222, and access points 224, 226, 228, 230, 232. Each of access points 224, 226, 208, 230, 232 may be coupled to the switch 222. Switch 222 may be

coupled to switch 202 through any one or more of a wired and a wireless medium. Although not shown, at least some of the access points in any one of the networking domains 214, 234 may be coupled to each other. Notwithstanding, a plurality of actual and/or virtual channels may be provided to facilitate communication with the access points and switches. Although the networking domains 214 and 234 are illustrated as separate networking entities, the invention is not so limited. Accordingly, the networking domain 214, 234 may be part of a single networking entity, but may represent separate security domains within the single networking entity.

[51] In operation, any one or more of the switches 202, 222 may be adapted to send network management related information and parameters to any one or more of the access points in any one or more of the networking domains 214, 234. In one embodiment of the invention, for example, switch 202 may be adapted to communicate bandwidth information to access point 206. Similarly, switch 202 may be adapted to send network management related information to any one or more of access points 204, 208, 210, 214. Similarly, switch 222 may be adapted to communicate network management related information to any one or more of access points 224, 226, 228, 230, 232.

[52] In another aspect of the invention, the switches 202, 222 may be adapted to provide, for example, certain QoS management activities to the access points using for example a messaging protocol. Accordingly, some activities such as bandwidth policing, bandwidth management, load balancing, roaming and handover may be handled by coordinating one or more switches and one or more access points utilizing, for example, the messaging protocol. Notwithstanding, a switch for example, switch 222, may be configured to establish rules that may be adapted by the access points 224, 226, 228, 230, 232 in carrying out these activities. The rules may be propagated from the switches 222, 202 to the access points 204, 208, 210, 214, 224, 226, 228, 230, 232 using, for example, the messaging protocol. Prioritization and processing, for example, may be based on acceptable levels of latency and bandwidth availability. For example, an IP telephone call may be assigned highest queuing and processing priority

in order to minimize latency. Policing, for example, may include tasks which may limit and control the usage of available bandwidth by a particular access device or a type of access device. In accordance with the invention, these and other tasks may be controlled by the switch using the messaging protocol.

[53] In accordance with an aspect of the invention, the switch may utilize the messaging protocol (MP) to provide enhanced communication services to one or more of a plurality of access devices or mobile stations in, for example, an enterprise Wireless LAN (WLAN). The enhanced communication, in addition to ordinary WLAN device communication such as authentication, authorization, key exchanges, beacon broadcast, etc., may provide additional features not provided by a WLAN to its clients. These additional features may include, but are not limited to, access control, load balancing, network management and quality of service. In addition to switches, other enterprise WLAN devices that may utilize messaging protocol message transactions may include but are not limited to, wireless access points, enterprise switches and wireless stations. These devices may be MP enabled in certain instances.

[54] In accordance with an aspect of the invention, an exemplary WLAN Architecture may be provided. In the enterprise Wireless LAN environment, the wireless devices may be located at the edge of the network. The wireless devices may be connected or coupled to the enterprise network via the one or more access points, which in turn may be the edge devices of, for example, a wired LAN. The access points may be connected to the LAN via switches. These switches, which may be called Wireless LAN Switches, in certain instances, do not only perform Layer 2 switching, but may be adapted to function as a wireless edge manager. They may also provide additional functionalities such as access control, firewall functions, traffic privacy and quality of service (QoS), network management, and load balancing.

[55] FIG. 3 is a block diagram 300 of an exemplary Enterprise Wireless LAN having switches serving as the edge managers in accordance with an embodiment of the invention. Referring to FIG. 3, there is shown, a local area network (LAN) 302, authentication server 304, switches 306, 308, access points (APs) 310, 312, 314, 316,

318, 320 and access devices 322, 324, 326, 328, 330, 332, 334, 336, 338. It should be recognized that the invention is not limited to and Enterprise WLAN. The invention may be applicable to a wired LAN, a wireless LAN and any combination thereof.

[56] Wireless transmission or communication between the access devices or clients, and the access points may be secure. This may be also be true for the wired connections between any of the access points 310, 312, 314, 316, 318, 320 and the switches 306, 308. The switches 306, 308 and access points 310, 312, 314, 316, 318, 320 may be adapted to communicate using, for example, an Ethernet protocol. From the switch's perspective, the switch may be switching regular layer 2 frames. However, within the switch, knowledge of a WLAN and its management intelligence may reside primarily in software. Notwithstanding, the invention is not limited in this regard.

[57] In accordance with an aspect of the invention, the switch may be adapted to utilize a messaging protocol, which may utilize one or more protocols associated with a device communication protocol (DCP) umbrella (DCPU). The messaging protocol utilized by the switch may be adapted to run over the transmission control protocol (TCP) or user datagram protocol (UDP) using for example, a well-known port number specified under the framework of the device communication protocol. Under the DCP umbrella, there may be several sub-protocols defined for the purpose of facilitating interoperability with other products. Some of these products may include but are not limited to, cable modems and cable modem termination systems (CMTS) equipment. The messaging protocol utilized by the switch may be adapted to include the necessary protocols under DCP to facilitate communication for wired and/or WLAN devices.

[58] DCP is a Layer 5 protocol. It may be adapted to use a default TCP/UDP port of for, example, 3188, which is a registered IETF port assignment. A DCP header, starting from the TCP/UDP payload, may have a 6-byte header as follows:

RCM_MAGIC_ NUMBER	RCM_SubProtocol	Sub_Protocol Specifics
octets 0-3 (= 0x4252434d, or "RCM")	octets 4-5	Variant # octets

The RCM_SubProtocol field may indicate an officially registered sub-protocol for other devices. Exemplary valid values may be illustrated in the following table:

RCM_SubProtocol	**Description**
0x0000	Reserved
0x0001	Propane Control Protocol (PCP)
0x0002	Inter-CMTS Communications Protocol (ICCP)
0x0003	imPulse Mitigation Signaling Protocol (PMSP)
0x0004	Loadbox Signaling Protocol (LBSP)
0x0005	Propane Testing Protocol (PTP)
0xFFFE	Reserved
0xFFFF	Reserved

The message protocol may be adapted to register for a next available value for the RCM_SubProtocol. Message protocol specific information may be adapted to start at the 6^{th} octet in the DCP packet, although the invention is not limited in this regard.

[59] In accordance with an aspect of the invention, the switch may utilize the messaging protocol to facilitate communication between various wireless networking devices and/or clients. In an embodiment of the invention, one or more of WLAN switches 306, 308 may be adapted to utilize the messaging protocol to facilitate communication with one or more of the access points 310, 312, 314, 316, 318, 320. Information exchanged between these two devices may include, but is not limited to, control, configuration and status information of the devices and also client session information. The control information may include, for example, signaling information that may be communicated in-band or out-of-band. Such information may be exchanged in order to enable in the WLAN, one or more of the six features mentioned above.

[60] The switch may utilize the messaging protocol, which may include a plurality of message types. In accordance with an aspect of the invention, the switch may utilize a messaging protocol that may include, for example, six (6) categories of messages or

message types. Notwithstanding, the invention is not so limited. These messages and their usage may be illustrated as follows:

AP_Status: from AP to Switch or AP

An AP_Status message may be used to indicate, for example, an access point capacity, bandwidth allocation, the number of attached clients, signal strength, power levels, etc.

AP_Config: from Switch to AP

An AP_Config message may be used to configure an access point to accommodate a client. This may include but is not limited to, 802.11e QoS, security information, etc.

Switch_Status: from Switch to Switch

A Switch_Status message may be used to indicate a switch's association with one or more clients. This may include but is not limited to, client session information, access control, QoS parameters, etc.

Switch_Config: from Switch to Switch

A Switch_Config message may be used to configure a switch such as a WLAN Switch to accommodate a client. The may include but is not limited to, access control, QoS configuration, etc.

Client_Status: from AP to Switch

A Client_Status message may be used to indicate a client's information. This may include but is not limited to, client identification, associated MAC address, session status, connecting location, etc.

Device_Discovery: any device to any device

In a client-server model of network services, the Device_Discovery message may be used by a switch and/or a server to discover clients or by client

to discover servers. The message may be broadcast to some or all devices in the subnet to draw responses from the intended devices.

[61] In each of the message types above, the message may include, for example four (4) message subtypes — .request, .data, .alert, and .ack. A message type/subtype pair of .request and .data may represent the request of data and a corresponding response of data itself. The subtype pair of .alert and .ack may represent the voluntary transmission of data and its acknowledgement. Additionally, there may be two conventions utilized in a message exchange sequence. Accordingly, if a message exchange sequence starts with a request (.req), it may be followed by a reactive transmission of data (.data). Similarly, if a message exchange sequence starts with a proactive transmission of data (.alert), it is followed by an acknowledgement (.ack).

[62] Since the messaging protocol utilized by the switch may be a sub-protocol of DCP, a messaging protocol message may have 6 octets at the front of the TCP/UDP Payload identifying it as a DCP packet. Starting from Octet 6 (0-based), at the beginning of a DCP payload, or a messaging protocol message, 3 octets may be reserved to indicate the message type of a messaging protocol message. In accordance with an aspect of the invention, the switch and one or more access points may include a filtering engine that may be adapted to filter certain types of messaging protocol messages by examining the three octets of a messaging protocol message. In this regard, a messaging protocol message identification system may be implemented for used by one or more switches and/or one or more access points.

[63] In accordance with an aspect of the invention, in a case where a messaging protocol (MP) message may be registered with a DCP sub-protocol value of, for example 0x0006, a typical messaging protocol message, as a continuation after the DCP header, may be as follows. Again, the beginning of the DCP header is the first byte of the TCP or UDP payload.

RCM_MAGIC_ NUMBER (octets 0-3)	RCM_ SubProtocol (octets 4-5)	MP Message Identifier (octets 6-8)	MP Message Payload (variant # bytes)
0x4252434d ("RCM")	0x0006	—	—

The messaging protocol Message Identifier may specify a type of messaging protocol messages as addressed above. The messaging protocol message types may be enumerated in the following table.

Message Type	value in first two octets of Message Identifier
AP Status	0x0001
AP Config	0x0002
Switch Status	0x0003
Switch Config	0x0004
Client Status	0x0005
Device Discovery	0x0006

[64] The 3rd byte of the messaging protocol message identifier may identify a sub-type of the messaging protocol Message. As addressed above, a messaging protocol message may be a data requisition, a data response, a data alert or an acknowledgement. The assigned values are given in the following table.

Message Sub-type	value in third octet of Message Identifier
data request (.req)	0x01
data response (.data)	0x02
data alert (.alert)	0x03
acknowledgement (.ack)	0x04

[65] The messaging protocol message payload may be ASCII-based, similar to other IETF protocols such as, real-time streaming protocol (RTSP), hyper-text transport

protocol (HTTP), session initiation protocol (SIP), etc. With an ASCII-based protocol, the parameters to be exchanged between devices may be formatted as follows:

```
<field{.subfield}>: <field value>
```

It should be recognized that the invention is not limited to the arrangement of the parameters as shown. Notwithstanding, a messaging protocol message in ASCII format may be recognized by inspection. Notably, the messaging protocol message format provides flexibility, in that future revision may be possible by adding new fields.

[66] United States Patent Application Serial No. 10/607,094 entitled "Communication System and Method in a Hybrid Wired/Wireless Local Area Network" filed on June 26, 2003, discloses a messaging protocol that may be utilized by the switch in accordance with an embodiment of the invention, and is incorporated herein by reference in its entirety. Exemplary valid fields and subfields for various messaging protocol messages that may be utilized by the switch are disclosed therein.

[67] In another aspect of the invention, the switch may utilize the messaging protocol to provide additional enhancements to 802.11-based networks beyond those which may be described in the 802.11 standards. These enhancements may occur in exemplary areas such as the detection of rogue network elements. In this regard, upon detecting signal coming from a new access point, a messaging protocol enabled access point may be adapted to send, for example, a Request.ID message to the new access point. The new access point may be adapted to respond with an appropriate network password. If an appropriate network password is received, then the access point may be considered part of the network. Otherwise, an alarm may be sent to a network management entity notifying of the existence of an unidentified access point. The network management entity may be a switch or an access point, although the invention is not limited in this regard. This mechanism may be particularly effective in an isolated domain where there may be minimal or no overlapping coverage from legitimate access points. The messaging protocol may further be used to facilitate the distribution of client access rules between switches during roaming. A switch may be adapted to utilize this

feature to facilitate seamless roaming between access points connected to different switches or on different network domains.

[68] In another embodiment of the invention, the switch may include a network management controller that may be configured for network management. In this regard, the switch may be adapted to utilize, for example, the messaging protocol to transfer networking monitoring and/or status messages such as SNMP and RMON statistics from an old attachment or connection point to a new connection point. In this regard, the switch may be configured to use the messaging protocol to enable location-specific management of at least certain clients and/or network devices. In this regard, the switch may send client association information to a central management entity which may be aware of the location of the various access points and/or switches in the network. This information may be disseminated to a Q0S controller and/or a load balancing controller. Accordingly, a decision may subsequently be made to determine whether to allow or disallow access from certain locations in order to balance a load within the network and/or provide a specified QoS.

[69] For example, information pertaining to at least some detected clients may be transferred to the switch. Accordingly, a load balancing manager and/or controller located in the switch may use this information to achieve efficient load balancing. In this regard, the load balancing controller may include suitable circuitry and/or software that may be adapted to receive and assess various client information and effectuate an efficient load balancing. Parameters such as signal strength, access level and device type, may be indicative of the information that may be used to effectuate efficient load balancing. Client association/dis-association information may be communicated between the load balancing manager and one or more access points and/or switches. Once the load-balancing manager determines an optimal load configuration, new client and/or access point association information may be passed to the various access points in the network using messaging protocol messages.

[70] In another embodiment of the invention, the switch may include a QoS controller that may be configured to utilize the messaging protocol to transfer QoS parameters

from an original switch port to a new switch port, in order to facilitate roaming. One or more switches in the network may be adapted to facilitate roaming between various access points located in the same network or between different networks. This may affect the QoS handling of, for example, downstream traffic destined for the roaming client or access device. In this regard, a switch may be adapted to utilize one or more messaging protocol messages to automatically transfer various pertinent network management parameters between access points and or other switches. This centralized management may eliminate a need for a distributed management interface, thereby providing a more robust communication system

[71] In another embodiment of the invention, to facilitate roaming, a switch may be adapted to utilize the messaging protocol to transfer QoS parameters from an old access point to a new access point. This may affect upstream traffic from the client to the AP in an HCF environment. In this regard, the switch may utilize one or more messaging protocol messages to transfer QoS parameters from the old AP to the new AP. Since this handling of QoS parameters may be similar to the handling of client traffic, the messaging protocol may be used to provide seamless roaming.

[72] In accordance with another aspect of the invention, a switch may be adapted to utilize the messaging protocol to acquire access point associated messages, for example in a "Get AP-Associated Sessions." FIG. 4 illustrates an exemplary exchange sequence between a switch 402 and an access point (AP) 404 based on a status request of the access point using the message protocol in accordance with an aspect of the invention. The switch may be a WLAN switch. Referring to FIG. 4, the WLAN switch 402 may request data for at least some of the sessions currently associated with the access point 404 using an AP_Stat.req message. The access point 404 may respond with a AP_Stat.data message. Detailed exemplary AP_Stat.req and AP_Stat.data in accordance with an embodiment of the invention are shown below. For illustrative purposes, the session information may be indicated by a "TBD" in the session field.

AP_Status.req

Transaction_ID: 000123223

Session.AP_ID: AD-1002

Session.Status: Associated

Session.*: TBD

AP_Status.data

Transaction_ID: 000123223

Session.ID: AD1002-23ECEB141A51-1009

Session.AP_ID: AD-1002

Session.Client_MAC: 23.EC.EB.14.1A.51

Session.Status: Associated

Session.Duration: 2309

Session.Signal: 95

***

Session.ID: AD1204-23AC41921A22-1084

Session.AP_ID: AD-1002

Session.Client_MAC: 23.AC.41.92.1A.22

Session.Status: Associated

Session.Duration: 589

Session.Signal: 92

***

Session.ID: AD2133-55ABACE29A21-1239

Session.AP_ID: AD-1002

Session.Client_MAC: 55.AB.AC.E2.9A.21

Session.Status: Associated

Session.Duration: 1004

Session.Signal: 23

***

[73] In this message, the access point reports three associated sessions back to the switch. Each associated session is separated by the delimiter "***". Only relevant fields may be reported. In this regard, the switch may not carry the Switch_ID information and thus it is not included in the record. This field may be filled out by the switch itself and

included whenever at least a portion of the session information gets transferred from a first switch to a second switch.

[74] The switch may further be adapted to utilize the messaging protocol to facilitate switch filter transfer. FIG. 5 illustrates a switch filter transfer using the messaging protocol in accordance with an embodiment of the invention. Whenever a wireless client or access device moves from a first access point coverage region or zone to a second coverage region or zone during a communication session, there is a possibility that the old and new access points may not be connected to the same WLAN switch. In this case, the switching intelligence may be required to transfer the communication session from the old WLAN switch 504 to the new WLAN switch 502. Accordingly, the messaging protocol may facilitate intelligent switching to provide access control and/or QoS management and control.

[75] During the transfer of a communication session from a first old switch 504 to a second new switch 502, switch filter information may have to be transferred from the old switch to the new switch. Referring to FIG. 5, the new switch 502 may be adapted to request switch filter information or configuration information from the old switch 504 using a Switch_Config.req. The old switch 504 may respond with a Switch_Config.data message. In an embodiment of the invention, an exemplary message exchange sequence may be illustrated as follows:

Switch_Config.req

Transaction_ID: 000123225
Classifier.SA: 23.EC.EB.14.1A.51
Classifier.*: TBD
Filter.*: TBD

[76] The new switch 502 may issue a request for upstream filtering information of a client device whose MAC address is 23-EC-EB-14-1A-51, for example. The new switch 502 may need at least some or all other classification information for this client device as well as any filtering action that may be configured for this client. An example follows:

Switch_Config.data

Transaction_ID: 000123225

Classifier.SA: 23.EC.EB.14.1A.51

Filter.Action: CHANGE_INTERNAL_PRIORITY & CHANGE_DSCP

Filter.802_1p: 5

Filter.DSCP: 0xA0

[77] The old switch 504 may be adapted to respond with the filtering information or configuration of the client device. While there may be no other fields to be classified for the client device, the invention is not so limited. Notwithstanding, the filtering actions may include, but is not limited to:

changing an internal priority of the packet to 5; and

changing a DSCP value of the packet to 0xA0.

Accordingly, this switch filter will be configured in the new switch 502, and removed from the old switch 504

[78] In yet another embodiment of the invention, the switch may be adapted to utilize one or more messaging protocol messages to locate an access device or client in a WLAN. In this regard, it may be necessary to discover which one of a plurality of access points a client device may be associated with. The whereabouts of a client device may be derived from this discovered access point association. For example, in a case where access points from three (3) different locations are getting strong signals from a particular client device, but no other access points receive any signal from that particular client device, then the client device may be located in a zone where coverage for the three (3) access points overlap. An actual location of the client device may subsequently be decided by, for example, a server, a switch and/or an access point, after receiving various feedback information from at least one of the three (3) access points. Although the server may be a separate network entity, it may be coupled to and/or associated with the switch and/or the access point.

[79] FIG. 6 illustrates an exemplary message exchange between a switch and an access point using a messaging protocol in accordance with an aspect of the invention.

In general, the switch 602 may initially send at least one Device_Discovery message to at least some of the access points for example 604, in the IP subnet of 192.168.xx.xx. The server 602 may be associated with a switch and/or access point and may be separate from or integrated therein. Switch 602 may broadcast a Device_Discovery message from switch 602 to the access points, for example 604, in the subnet. Responsive to replies associated with the Device_Discovery message, the switch 602 may send individual AP_Status request messages to each access point, for example 604, located within the subnet.

[80] Referring to FIG. 6, switch 602 may send a Device_Discovery.req message to AP 604. AP 604 may respond with a Device_Discovery.data message. Switch 602 may send an AP_Status.req to access point 604. Access point 604 may respond with a AP_Status.data message. The following illustrates exemplary messaging protocol messages that may be utilized by a switch to discover a client device.

Device_Discovery.req
- Transaction_ID: 000123293
- Target_Device.Type: AP
- Target_Device.Address_Filter: 192.168.xx.xx
- Target_Device.Filter_Type: IP
- Target_Device.Identity: TBD
- Device_Discovery.data
- Transaction_ID: 000123293
- Target_Device.Type: AP
- Target_Device.Address_Filter: 192.168.xx.xx
- Target_Device.Filter_Type: IP
- Target_Device.Identity: AD-1002
- AP_Status.req
- Transaction_ID: 000123294
- Session.Client_MAC: 23.EC.EB.14.1A.51
- Session.AP_ID: AD-1002
- Session.Status: TBD

Session.Signal: TBD

AP_Status.data

Transaction_ID: 000123294

Session.Client_MAC: 23.EC.EB.14.1A.51

Session.AP_ID: AD-1002

Session.Status: Associated

Session.Signal: 85

[81] In a case where another client device, for example AD-1082, also receives a strong signal from the client device, but the client device is not associated with that access point, the AP_Status.data response may have the following value:

Transaction_ID: 000123295

Session.Client_MAC: 23.EC.EB.14.1A.51

Session.AP_ID: AD-1082

Session.Status: Not-associated

Session.Signal: 79

[82] In a case where another access point, for example AD-1203, does not get any signal from the client device, the AP_Status.data response may have the following value:

Transaction_ID: 000123296

Session.Client_MAC: 23.EC.EB.14.1A.51

Session.AP_ID: AD-1203

Session.Status: Not-associated

Session.Signal: 0

[83] In accordance with another aspect of the invention, the switch may be adapted to utilize the messaging protocol to locate a client device or access device within a Wired LAN. The client device or access device may be, for example an IP telephone. An IP telephone and an IP Telephony Gateway (IPTG) may both be message protocol-enabled. The switch may initiate a discovery or locate process by send a request to the IPTG. In this regard, the IP telephone and the IPTG may exchange messages whenever a client device is first connected to a wired LAN. When the IP telephone is

coupled to the wired LAN, the IP telephone may first acquire an IP address. Subsequently, the IP telephone may be adapted to send a broadcast message to a subnet of the wired LAN in order to search for the IPTG serving the subnet of the wired LAN. Devices other than the IPTG may ignore the broadcast message. The IPTG may responds with its own client identification. Subsequently, the IP telephone may communicate call processing related messages with the IPTG. The call processing information may be communicated to the switch.

[84] FIG. 7 is an exemplary diagram illustrating an exemplary message exchange for locating a wired client device using the messaging protocol in accordance with an embodiment of the invention. In general, the client device 702 may first broadcasts a Device_Discovery message to the IP subnet of 192.168.xx.xx, in order to locate the serving IPTG 704. Based on responses associated with the broadcast Device_Discovery message, the IPTG 704 may identify itself with its IP address, for example 192.168.12.22. Referring to FIG. 7, the IP telephone client device 702 may send a Device_Discovery.req to the IPTG 704. The IPTG 704 may respond with a Device_Discovery.data message. The following is an exemplary messaging protocol message that may be utilized by the switch to locate a wired client device in accordance with an embodiment of the invention.

Device_Discovery.req

Transaction_ID: 000138293

Target_Device.Type: IPTG

Target_Device.Address_Filter: 192.168.xx.xx

Target_Device.Filter_Type: IP

Target_Device.Identity: TBD

Device_Discovery.data

Transaction_ID: 000138293

Target_Device.Type: IPTG

Target_Device.Address_Filter: 192.168.xx.xx

Target_Device.Filter_Type: IP

Target_Device.Identity: 192.168.12.22

[85] In a case where it may be necessary to determine an actual or physical location of an IP phone, any switches located between the IP telephone and the IPTG may be utilized to determine the actual location. In this regard, a client device discovery process may be adapted to have the capability to identify, for example an edge switch, which may be directly connected to the IP phone. Switch information, and/or wiring plan information, may be used to indicate the actual or physical location of a jack in which the IP telephone may be plugged. The switch may include suitable filtering logic and/or software, which may be adapted to filter at least some or all Device_Discovery messages in a messaging protocol message and record some or all IP address and/or physical port mappings. The port may be an edge port in a spanning tree state, which may indicate that the IP telephone may not be connected to another switch. Accordingly, these records may subsequently be sent to the IPTG where it may be stored. Any future query for the physical location of that IP telephone may be answered by searching these records and extracting information from the stored records.

[86] FIG. 8 is a block diagram 800 of an exemplary switching system for network management in a wireless local area network. Referring to FIG. 8, there is shown a CPU block 802 and a switching fabric block 804. The CPU block 802 may include a quality of service (QoS) controller block 806, a load balancing controller block 808, a session controller block 810 and a network management control block 812. The switching fabric block 804 may include a filtering engine block 814. The CPU block 802 may be adapted to interface with the switching fabric block 804. One or more of the QoS controller block 806, load balancing controller block 808, session controller block 810 and network management control block 812 may interface directly with the filtering engine block 814.

[87] In operation, selected signaling packets may be communicated from the switching fabric block 804 to one or more of the QoS controller block 806, load balancing controller block 808, session controller block 810 and network management control block 812. Messaging protocol messages may be used to facilitate communication between the switching fabric block 804 and one or more of the QoS

controller block 806, load balancing controller block 808, session controller block 810 and network management control block 812. The selected signaling packets may include, but are not limited to, VoIP packets, and streaming media packets including voice, video and data. The filtering engine block 814 may be adapted to filter information received from one or more of the QoS controller block 806, load balancing controller block 808, session controller block 810 and a network management control block 812. In this regard, the filtering engine block 814 may be adapted to filter messaging protocol messages used to control switching functions, network traffic statistics messages, layer two (2) address update messages, and filter update messages. The filter update messages may include, but is not limited to, access control messages, QoS messages and load balancing messages.

[88] In accordance with an embodiment of the invention, the switching system for network management may include a session control process that may be adapted to manage and control at least one client database and session information for some or all active clients. The session control process may be configured to enforce access control based on, for example, a client session, a subnet, a network management application, and switch ports. Access control, for example, may be used to facilitate load balancing in at least a portion of the network. The session control process may also control and manage switching intelligence for roaming.

[89] FIG. 9 is a block diagram 900 of an exemplary session control process as described in FIG. 8 that may be utilized by the switching system for network management in accordance with an embodiment of the invention. Referring to FIG. 9, there is shown a session control process 902 having a client database 904, an access control list (ACL) database 906, a session control manager 908 and a VoIP enabler 910. One or more interfaces may be adapted to provide communication between session manager 908 and the client database 904 and the ACL database 906. The session manager 908 may include at least one interface that may be adapted to facilitate communication with the VoIP enabler 910.

[90] In operation, the session control manager 908 may be adapted to process messaging protocol messages, layer two (2) updates, and filter updates. The session control manager 908 may be adapted to receive information from one or more of client database 904 and ACL database 906. The VoIP enabler 910 may be adapted to process VoIP signaling packets. VoIP enabler 910 may also be adapted to decode various standards-based VoIP signaling packets and prioritize filter setup.

[91] In an embodiment of the invention, the switching system may include a load balancing process that may be adapted to obtain access point load from, for example a network management process. The network management process may include but is not limited to SNMP, RMON, RMON2, and MIB. The load balancing process may be adapted to keep an access point database on, for example, a plurality or bank of access points. The load balancing process may include necessary intelligence for making load distribution decisions.

[92] FIG. 10 is a block diagram 1000 of an exemplary load balancing process as described in FIG. 8 that may be utilized by the switching system for network management in accordance with an embodiment of the invention. Referring to FIG. 10, there is shown a load balancing process 1002 having an access point database 1004 and a load balancing manager 1006. At least one interface may be adapted to provide communication between access point database 1004 and the load balancing manager 1006. The load balancing manager 1006 may be adapted to include at least one interface that may facilitate communication with a network management process.

[93] In operation, the load balancing manager 1006 may be adapted to process messaging protocol messages, layer two (2) updates, and filter updates. The load balancing manager 1006 may receive network statistics from a one or more network management processes. Information from the access point database 1004 may be utilized by the load balancing manager 1006 for making load balancing decisions.

[94] In an embodiment of the invention, the switching system for network management may include a QoS enabling process that may be adapted to control and

manage activities such as, traffic policing, metering filters, and protocol configurations. In this regard, the QoS enabling process may be adapted to manage, for example, 8012.11e based configurations that may be sent to the access point. A VoIP enabler may be adapted to decode various standard-based VoIP signaling packets and prioritize filter setup.

[95] FIG. 11 is a block diagram 1100 of an exemplary QoS enabling process as described in FIG. 8 that may be utilized by an the switching system for network management in accordance with an embodiment of the invention. Referring to FIG. 11, there is shown QoS enabling process 1102 having QoS policy database 1104, a QoS manager 1106 and a VoIP enabler 1108. At least one interface may be adapted to provide communication between QoS policy database 1104 and the QoS manager 1106. The QoS manager 1106 may be adapted to include at least one interface that may facilitate communication with, for example, the VoIP enabler 1108.

[96] In operation, the QoS manager 1106 may be adapted to process, for example, messaging protocol messages, and filter updates. The QoS manager 1106 may send and receive VoIP signaling information to and from VoIP enabler 1108. Information from the QoS policy database 1104 may be utilized by the QoS manager 1106 for making QoS decisions.

[97] FIG. 12 is a block diagram 1200 of an exemplary switch 1202 in accordance with an aspect of the invention. Referring to FIG. 12, there is shown a processor 1210, transmitter 1204, receiver 1206, generator 1208 and controller 1212. The controller 1212 may include QoS controller 1214, load balancing controller 1216, session controller 1218 and network management controller 1220. The transmitter 1204, receiver 1206, generator 1208 and the components of the controller 1212, namely QoS controller 1214, load balancing controller 1216, session controller 1218 and network management controller 1220, may be variously coupled to processor 1210. The components of switch 1202 may include suitable circuitry and/or software capable of implementing the various functions. Notwithstanding, it should be readily be understood by one skilled in the art that although the components of the switch are individually

shown, the invention is not limited in this regard. For example, with suitable software and/or logic, the generator function 1208 may be implemented solely by the processor 1210.

[98] The transmitter 1204 may be adapted to send a first messaging protocol message between a first switch and a first access point. The receiver 1206 may be adapted to receive a second messaging protocol message from the first access point and the first switch. In response to the transmittal of the first messaging protocol message, a second messaging protocol message may be received. The controller 1212 may be adapted to control one or more devices using the first messaging protocol message, second messaging protocol message and/or third messaging protocol message. These devices may include but are not limited to the first switch, a second switch, the first access point, the second access point, and one or more access devices.

[99] The generator 1208 may be adapted to generate the first messaging protocol message by the first switch. The receiver 1206 may be adapted to receive the second messaging protocol message from a second switch. The processor 1210 may be adapted to control the transmitter 1204, the receiver 1206, the controller 1212 and the generator 1208. The processor 1210 may utilize one or more messaging protocol messages to control transmitter 1204, receiver 1206, generator 1208, QoS controller 1214, load balancing controller 1216, session controller 1218 and network management controller 1220.

[100] In accordance with another embodiment of the invention, dependent on the modulation scheme utilized, one or more of the PLCP frames illustrated in FIG. 1b, FIG. 1c, FIG. 1d and FIG. 1e may be adapted to contain information which may be utilized for providing communication in accordance with various embodiments of the invention. Additionally, the PLCP frames may be adapted to convey information for any one or more of the 801.11a, 802.11b and 802.11g modes of operation utilized by access points and/or access devices in accordance the embodiments of the invention.

[101] Accordingly, the present invention may be realized in hardware, software, or a combination of hardware and software. The present invention may be realized in a centralized fashion in one computer system, or in a distributed fashion where different elements are spread across several interconnected computer systems. Any kind of computer system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software may be a general-purpose computer system with a computer program that, when being loaded and executed, controls the computer system such that it carries out the methods described herein.

[102] The present invention also may be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

[103] Notwithstanding, the invention and its inventive arrangements disclosed herein may be embodied in other forms without departing from the spirit or essential attributes thereof. Accordingly, reference should be made to the following claims, rather than to the foregoing specification, as indicating the scope of the invention. In this regard, the description above is intended by way of example only and is not intended to limit the present invention in any way, except as set forth in the following claims.

[104] While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular

embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.